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FIRE ENDURANCE TEST OF
[illegible] BULKHEAD ASSEMBLIES

BY

J. V. Ryan

Fire Protection Section
Building Technology Division

For

U. S. Coast Guard

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NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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FIRE ENDURANCE TEST
OF
THREE BULKHEAD ASSEMBLIES

ABSTRACT

Three bulkhead assemblies were subjected to standard fire tests to determine their suitability for approval by the U. S. Coast Guard for use on merchant vessels. The three assemblies differed only in the details of the joint system. The unexposed surface temperatures of each remained within the specified limits for more than 15 min. Two remained effective barriers to the passage of flame throughout the 1 hour test, the third for over 30 min.

1. INTRODUCTION

As requested by the U. S. Coast Guard, in a letter dated November 15, 1955 (and as discussed in previous correspondence, reference JJ/164.008/33) three "Mavilite" bulkhead assemblies were subjected to a fire endurance test in compliance with Subpart 164.008-3(b) of Specification for Bulkhead Panels for Merchant Vessels. The assemblies were manufactured by Dansk Eternit-Fabrik A/S, Denmark, and shipped to the National Bureau of Standards ready for erection in the test frame. The test was conducted December 5, 1955.

2. TEST SPECIMENS

The three test specimens were alike, except for the details of the vertical joint located in each, consisting of 7/8 in. thick "Mavilite" suitably mounted for placement in the furnace test frame. Each bulkhead specimen consisted of two panels of "Mavilite", one 7 ft 10-1/8 in. high by 2 ft 8-3/4 in. wide and the other 7 ft 10-1/8 in. high by 1 ft 4-1/4 in. wide, butted together along their height. The Mavilite was secured to the test frame as shown in figure 1. The joint for the bulkhead of construction I consisted of a steel spline 0.79 by 0.12 in. by full height that fit into a groove in the butted edges of each Mavilite panel. That for the bulkhead of construction II consisted of an iron flat 2.95 in. wide, 0.16 in. thick, and full height secured to each face by 1 in. round head screws at about 1 ft on centers and staggered right and left of the joint. The joint system for the bulkhead of construction III consisted of a 1.75 by 0.12 in. steel strip secured to each face by flat head machine screws through the Mavilite. The heads of the screws fit in countersunk holes in the steel strip on the fire exposed face and the threaded ends screwed into tapped holes in the strip on the other face. The screws were about 1 ft on centers and staggered right and left of the joint.

FIRE ENDURANCE TEST
OF
TEMPO MOLDED ASBESTOS

ABSTRACT

Three bulkhead assemblies were subjected to standard fire tests to determine their suitability for approval by the U. S. Coast Guard for use on merchant vessels. The three assemblies differed only in the details of the joint system. The measured surface temperatures of each remained within the specified limits for more than 15 min. The proposed effective barriers to the passage of flame throughout the 1 hour test, the joints for over 30 min.

1. INTRODUCTION

As requested by the U. S. Coast Guard, in a letter dated November 15, 1955 (and as discussed in providing correspondence, reference 46/A/.000/55) three "Navitex" bulkhead assemblies were subjected to a fire endurance test in compliance with subpart 164.009-3(b) of Specifications for Bulkhead Materials for Merchant Vessels. The assemblies were constructed by Tempo Structo-Tubular Corp., Newark, and shipped to the National Bureau of Standards ready for erection in the test frame. The test was conducted December 7, 1955.

2. TEST DETAILS

The three test specimens were alike, except for the details of the vertical joint located in each, consisting of 2½ in. thick "Navitex" asbestos board for placement in the furnace test frame. Each bulkhead specimen consisted of two panels of "Navitex", one 7 ft 10-1/8 in. high by 1 ft 5-3/4 in. wide and the other 7 ft 10-1/8 in. high by 1 ft 4-1/4 in. wide, butted together along their length. The Navitex was secured to the test frame as shown in Figure 1. The joint for the bulkhead assemblies 1 consisted of a steel angle 6.77 lb 6.12 in. by 7.11 weight that fit into a groove in the butted edges of each Navitex panel. That for the bulkhead assemblies 11 consisted of an iron flat 2.93 in. wide, 0.12 in. thick, and full height secured to each face by 1 in. round head screws at about 1 ft on centers and staggered right and left of the joint. The joint system for the bulkhead of construction III consisted of a 1.75 by 0.12 in. steel strip secured to each face by flat head machine screws through the Navitex. The inside of the machine fit in countersunk holes in the steel strip on the fire exposed face and the threaded ends secured into tapped holes in the strip on the other face. The screws were about 1 ft on centers and staggered right and left of the joint.

3. TEST METHOD

The three bulkheads were mounted in a single test frame that had been subdivided for bulkhead tests. Eight thermocouples were placed on the unexposed surface of each bulkhead under 6 by 6 by 0.4 in. felted asbestos pads. Of these eight, three were along the joint and the others on the 2 ft 8-3/4 in. wide panel of Mavilite. Eight thermocouples were used on each bulkhead rather than nine so that the data from the three bulkheads could be recorded on two 12 point recording potentiometers. Other than for the number of unexposed surface thermocouples, the test was conducted in compliance with the provisions of Subpart 164.008-3(b) of Specification for Bulkhead Panels for Merchant Vessels. The furnace fires were controlled to produce temperatures as close as feasible to those defined by the standard time-temperature curve of ASTM E119-53, which include 1000°F at 5 min, 1300°F at 10 min, 1550°F at 30 min, and 1700°F at 1 hour.

4. RESULTS

The condition of the specimens immediately before the test is shown in figure 2. In addition to the personnel of the MMB Fire Protection Section, the following witnessed the test:

R. A. Adams, LCDR, USCG, Washington, D. C.
E. P. Boyle, Lt, USCG, Washington, D. C.
W. V. Morsing-Larsen, Dansk Eternit-Fabrik, Aalborg, Denmark

4.1 Observations During Test

The metal strip over the joint on the exposed surface of bulkhead III was bowed 2 to 3 in. away from the surface near midheight at 6-1/2 min. That on the exposed surface of bulkhead II was bowed away over the upper half of its height at 8 min. That on the unexposed surface of bulkhead III was bowed out slightly just below midheight at 10 min. A diagonal crack 2 in. long had developed by 23 min in the unexposed surface of bulkhead II adjacent to the top of the joint. The spline in bulkhead I had broken through the unexposed surface at midheight and bowed 4 to 5 in. from its initial position by 29 min. A horizontal crack across part of the wider (2 ft 8-1/4 in.) section of bulkhead II about 2-1/2 to 3 ft from the bottom was observed at 31 min. At the same time, the glow of the furnace was visible through the crack observed at 23 min.

The crack in bulkhead II observed at 31 min had extended across all the wider section and a similar crack extended across the narrower section by 36 min. At this time, the bulkheads had deflected from their original positions, as measured at midheight, as follows: bulkhead I, 0.65 in.; bulkhead II, 2.35 in.; bulkhead III, 1.2 in., all towards the fire. The glow of the furnace was visible through the horizontal crack in the narrow section of bulkhead II at 40 min. A crack 3 to 4 in. long had developed through the Maviite at midheight along one edge of bulkhead I at 44 min. A fine horizontal crack had developed across the narrow section of bulkhead III at 49 min whereas the crack across bulkhead II was about 1/8 in. wide. Glow was visible in the crack in bulkhead III at 57 min. The test was stopped at 1 hour.

4.2 Temperatures

The fire exposure severity was 99.0 percent of standard. The temperatures on the unexposed surfaces of the three specimens had risen 250°F above the initial at the times indicated in the following table.

	250 degree F rise	
	Panel	Joint
	h:m	h:m
Bulkhead I (spline)		
Average	0:21.1	0:18.6
One point	0:17.4	0:17.4
Bulkhead II (screws)		
Average	0:19.5	0:21.9
One point	0:17.1	0:17.4
Bulkhead III (machine screws)		
Average	0:20.5	0:19.8
One point	0:17.3	0:18.4

Reproductions of the potentiometer charts, indicating the recorded temperatures in detail, are given at the end of this report.

4.3 Condition After Test

At the end of the test, each bulkhead was bowed toward the furnace fires and had one or more horizontal cracks in the exposed surface. Bulkheads II and III also had significant cracks in the unexposed surface. Cracks in both sections of bulkhead II and in the narrow section of bulkhead III spanned all the way across the respective sections and completely through the Duvilite. The condition of the specimens was not noticeably changed after overnight cooling.

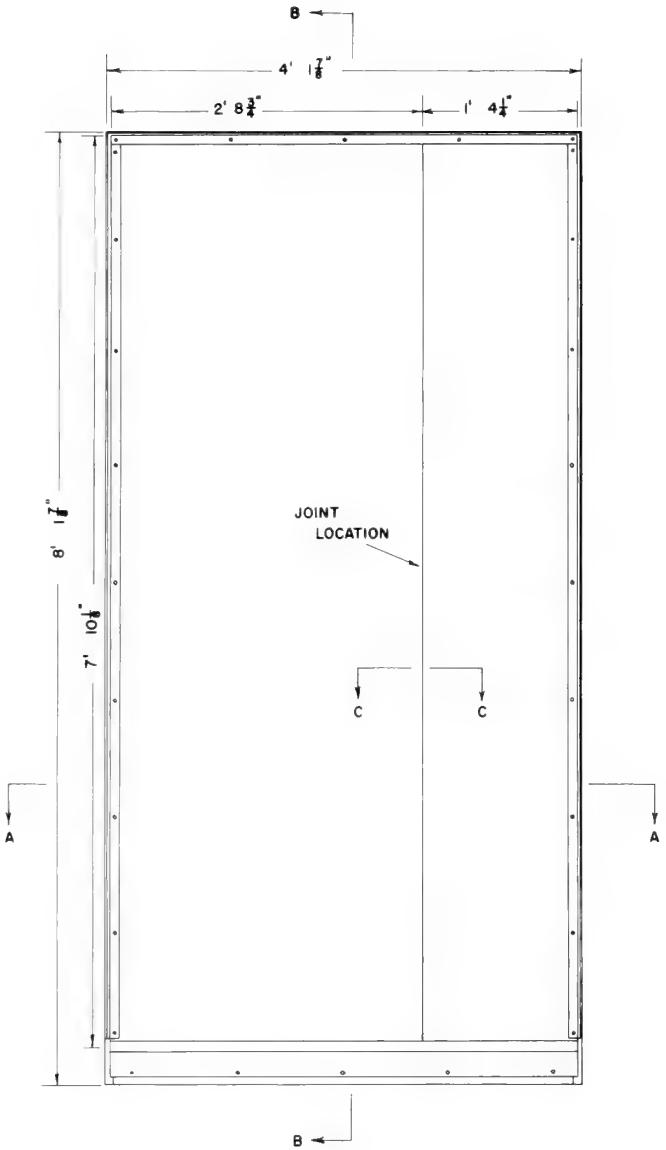
5. SUMMARY

Bulkhead I exhibited considerable deflection. The spline broke through the exposed surface but there was no other significant damage. The temperatures on the unexposed surface remained within the specified limits for 17 min and the specimen remained an effective barrier to flames for the full 1 hour test period.

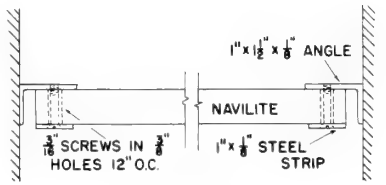
Bulkhead II also exhibited considerable deflection. The metal strip over the joint on the exposed surface broke loose over a major portion of its height early in the test. That on the unexposed surface became detached from the wide section of Duvilite in the top 1 to 2 ft. A small piece of the Duvilite broke off the top of the wide section at the joint and the sections became offset at the top. The glow of the furnace was visible at that location at 31 min, and through a crack across the narrow section at 40 min. The temperatures on the unexposed surface remained within the specified limits for 17 min and the specimen remained an effective barrier to flames throughout the first 30 min of the test period.

Bulkhead III exhibited considerable deflection. The metal joint cover strips buckled between the machine screws at two places on the exposed surface and one on the unexposed surface but did not break free of any of the machine screws. A crack developed across the narrow section and through the Duvilite late in the test, but it did not open appreciably. The temperatures on the unexposed surface remained within the specified limits for 17 min and the specimen remained an effective barrier to flames throughout the entire 1 hour test period.

Figure 1. Mounting and construction details.
[illegible] Reg. [illegible]

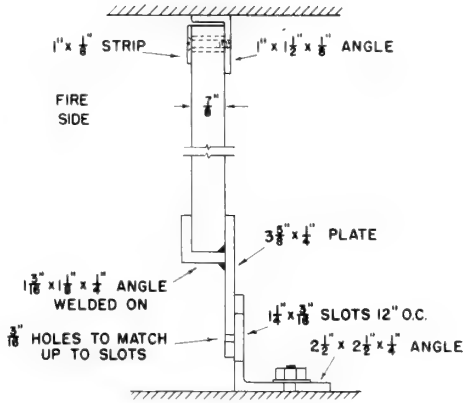


BULKHEAD TEST MOUNTING, FROM FIRE SIDE

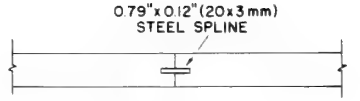


FIRE SIDE

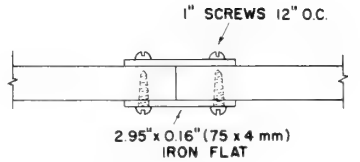
SECTION A-A



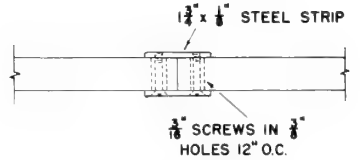
SECTION B-B



CONSTRUCTION I



CONSTRUCTION II



CONSTRUCTION III

SECTION C-C
JOINT DETAILS

Figure 2. Unexposed surface before test. Construction I, II, III from left to right. [illegible] Reg. [illegible]

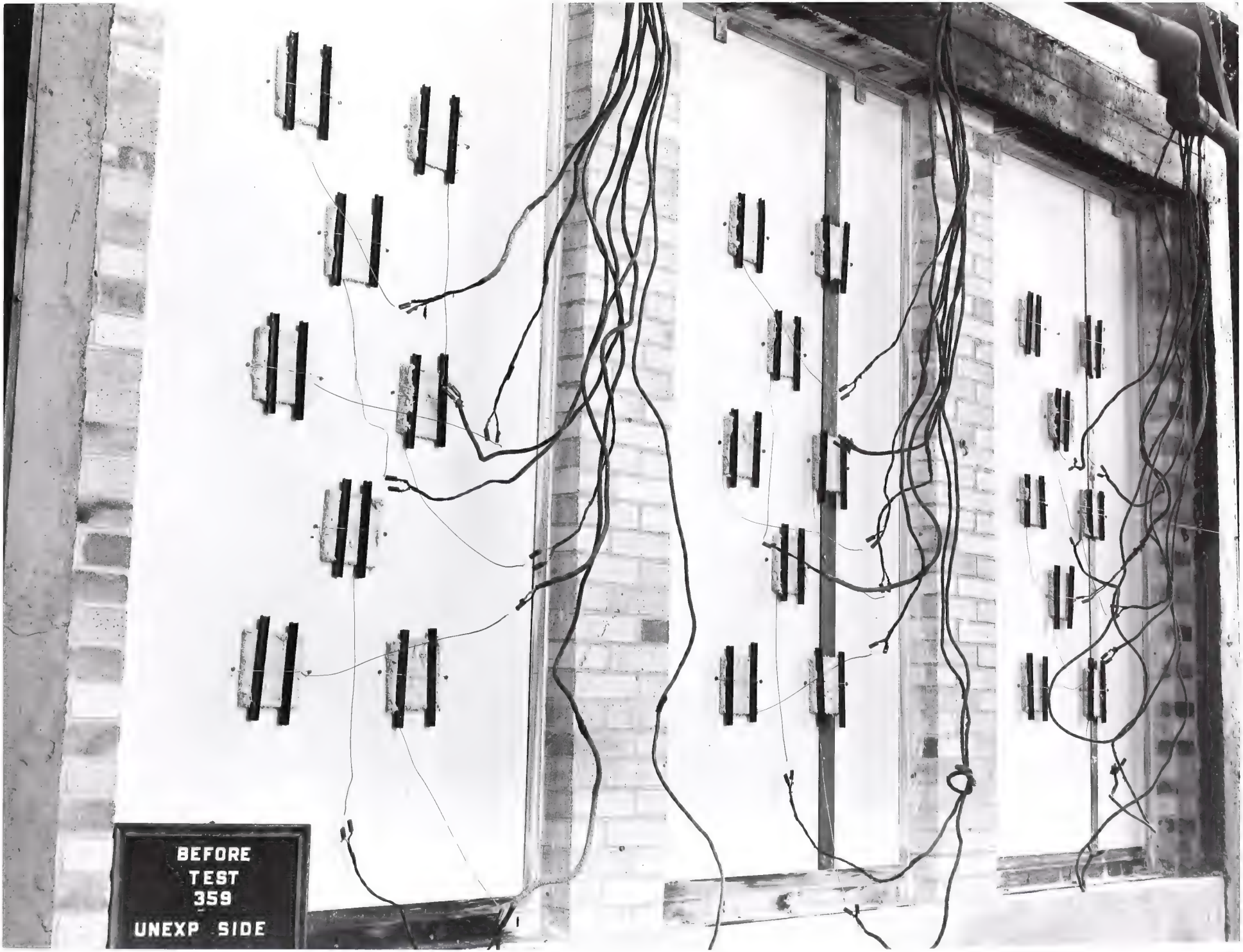

BEFORE
TEST
359
UNEXP SIDE

Figure 3. Unexposed surface at end of test. [illegible]
Seq. [illegible]

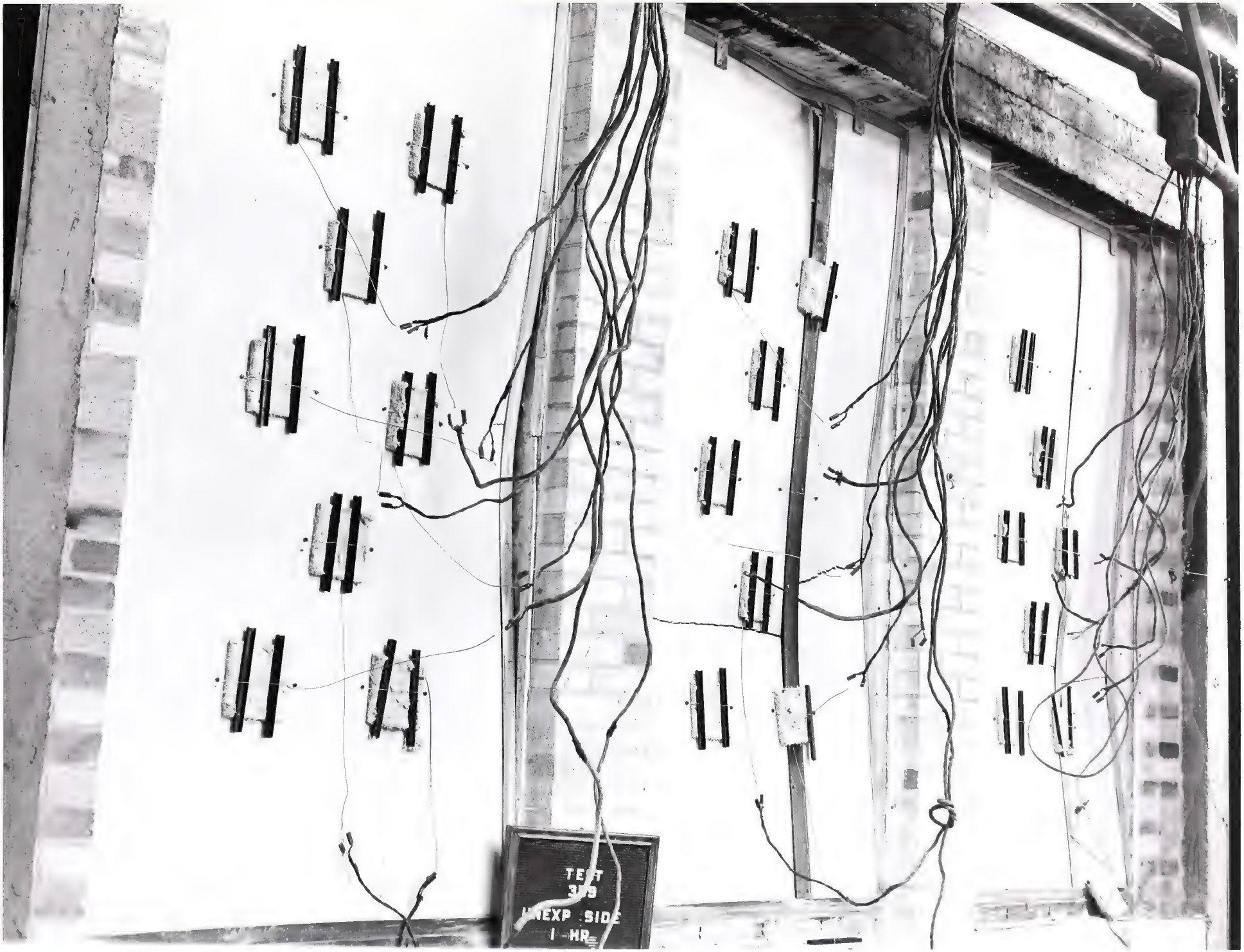

TEST
3/9
UNEXP SIDE
1 HR

Figure 4. Exposed surface after test, constructions I, II, III from right to left. [illegible] Neg. 45337-3

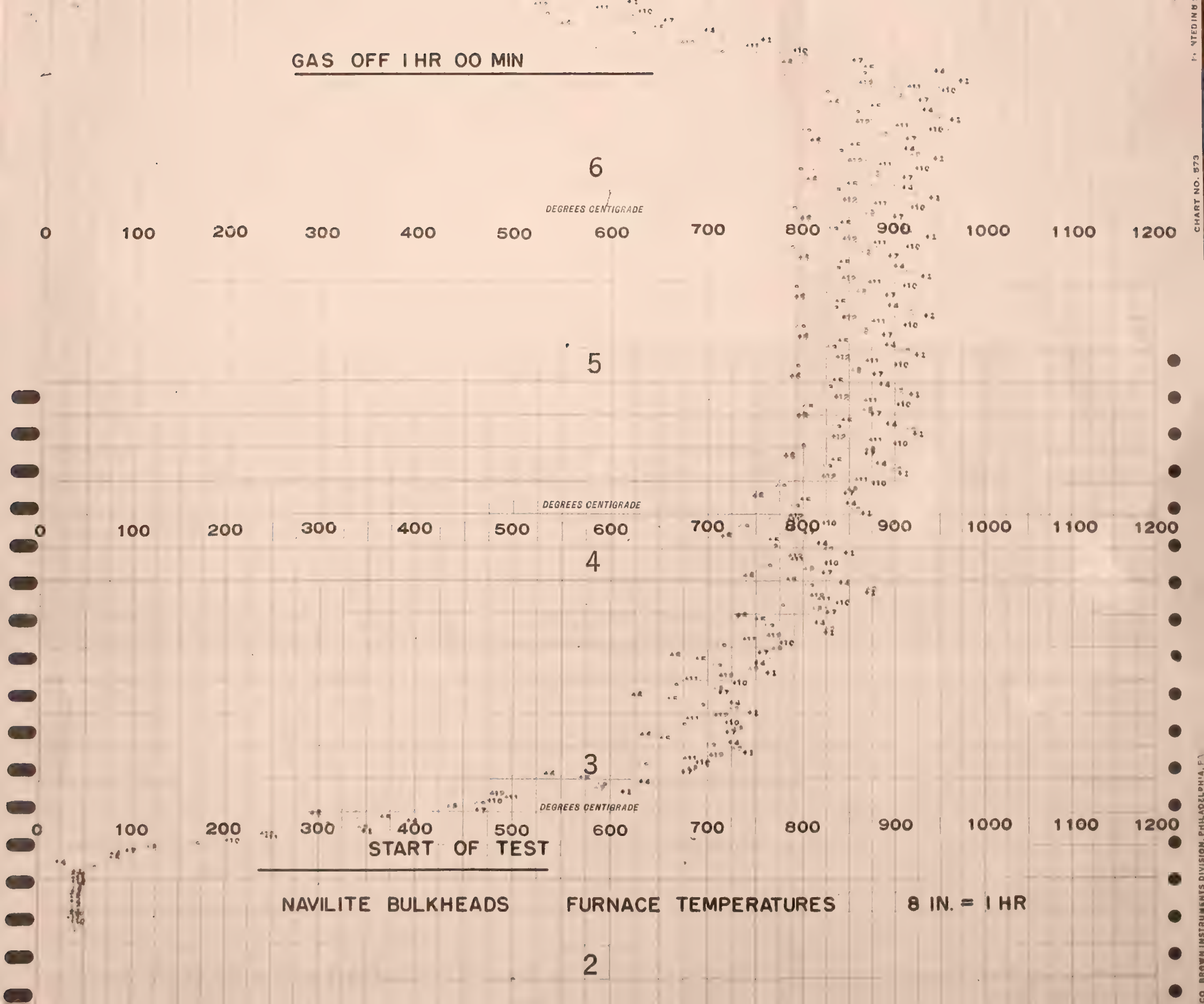
GAS OF

0 100 200 300

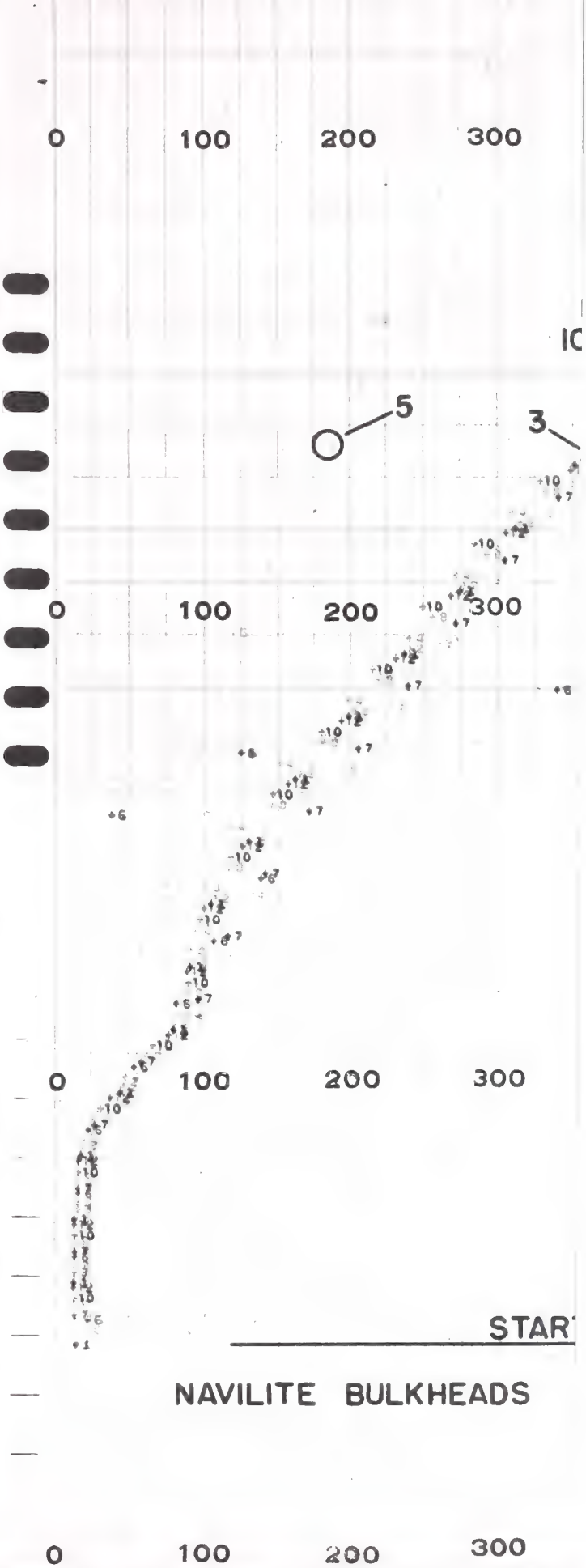
0 100 200 300

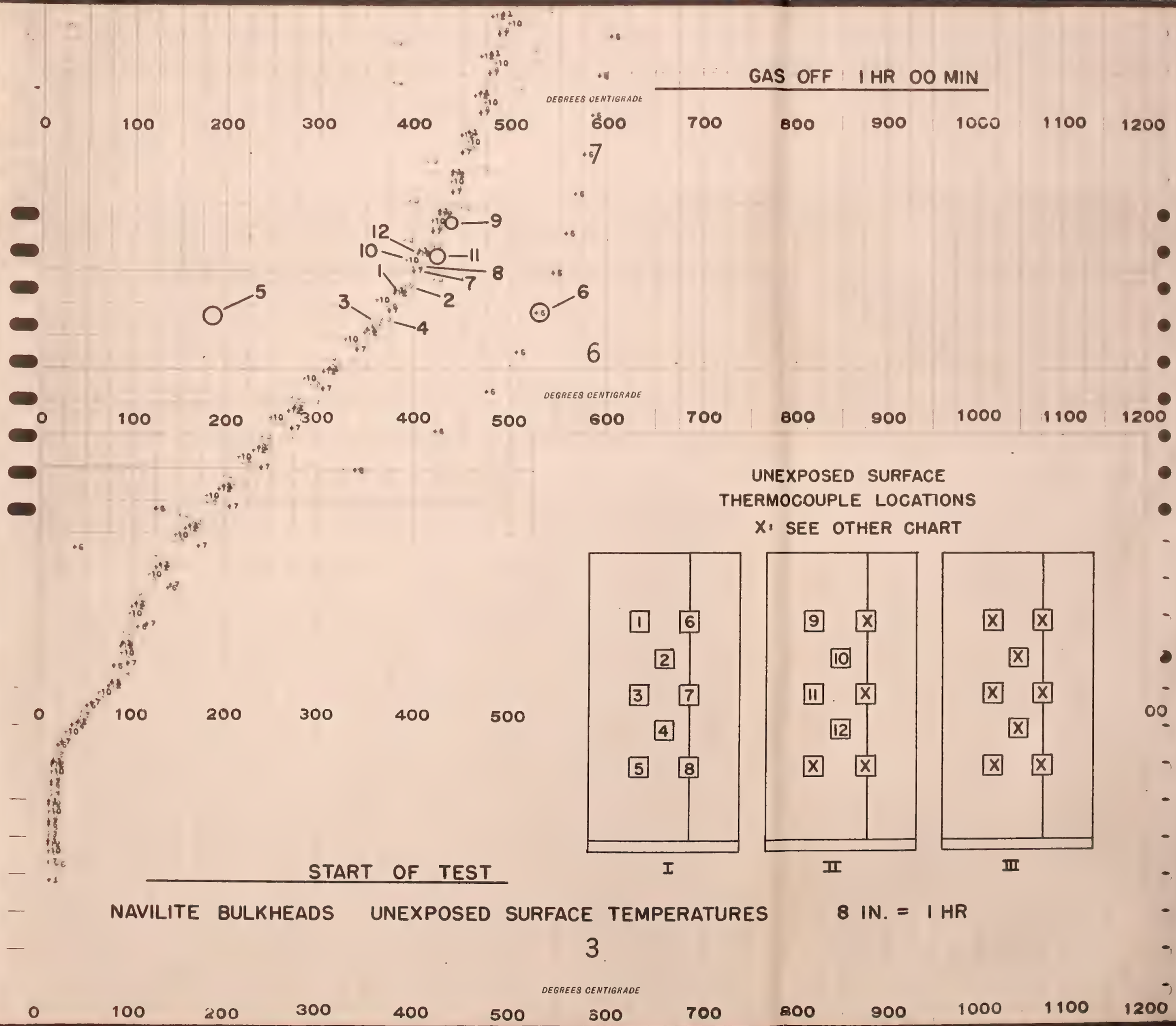
0 100 200 300

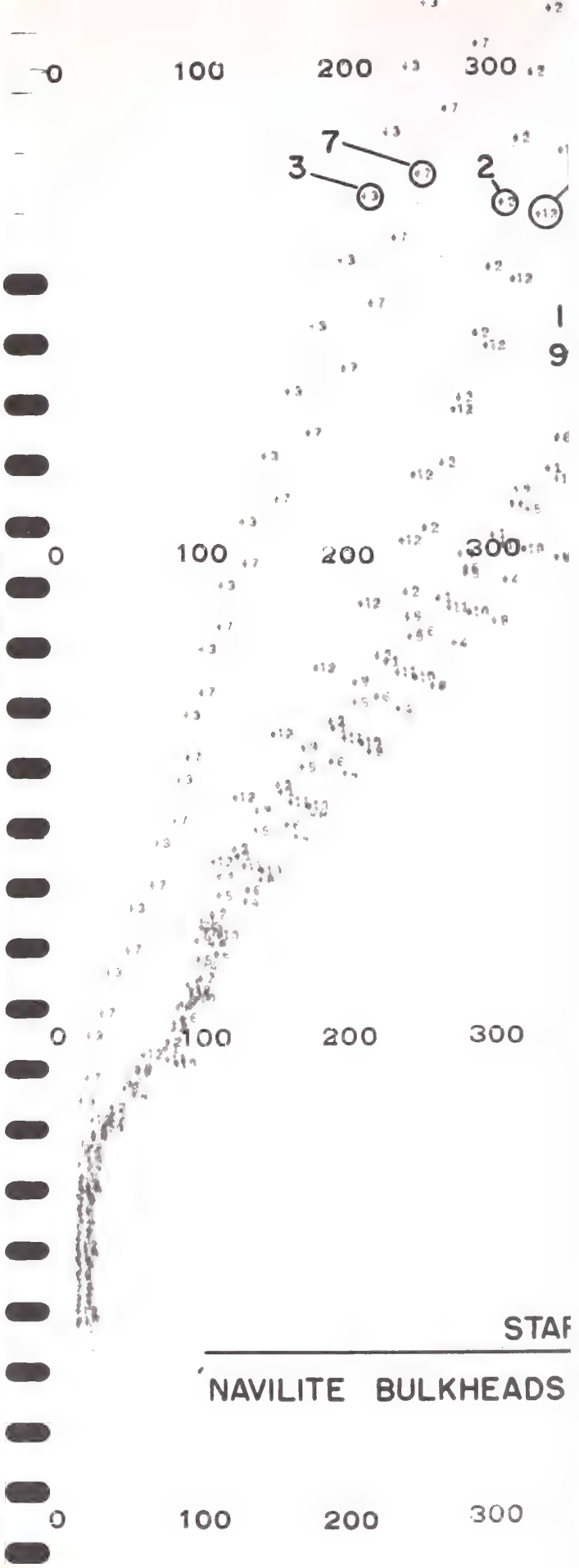
NAVILITE

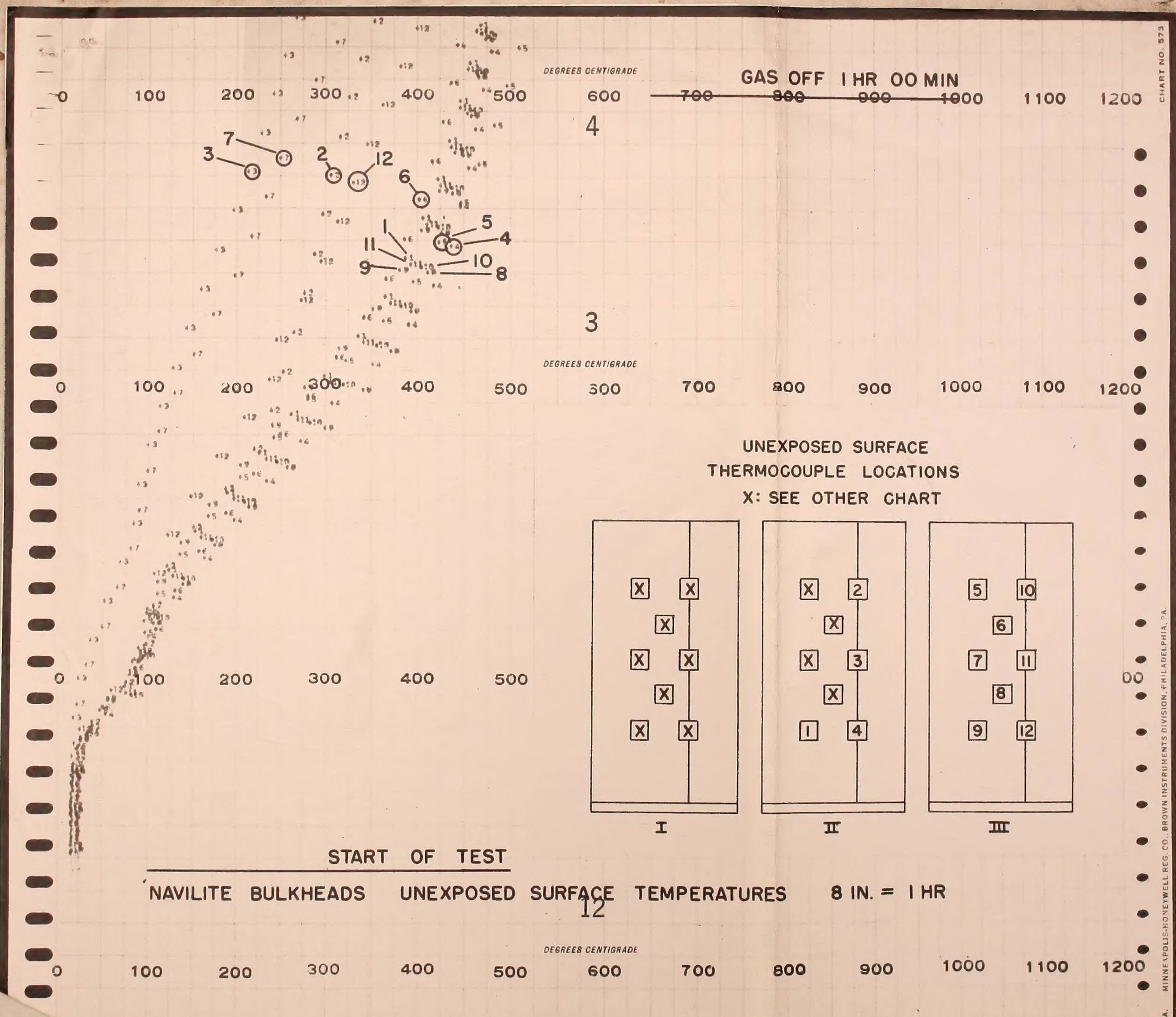


NAVILITE BULKHEADS FURNACE TEMPERATURES 8 IN. = 1 HR


0
100
200
300
10
5
3
STAR
NAVILITE BULKHEADS


GAS OFF 1 HR 00 MIN
DEGREES CENTIGRADE
0 100 200 300 400 500 600 700 800 900 1000 1100 1200
UNEXPOSED SURFACE
THERMOCOUPLE LOCATIONS
X: SEE OTHER CHART
I
II
III
START OF TEST
NAVILITE BULKHEADS UNEXPOSED SURFACE TEMPERATURES
8 IN. = 1 HR
3
PRINTED IN U.S.A. MINNEAPOLIS-HONEYWELL REG. CO., BROWN INSTRUMENTS DIVISION, PHILADELPHIA, PA.
CHART NO. 573


0
100
200
300
7
3
2
1
9
0
100
200
300
0
100
200
300
STAF
NAVILITE BULKHEADS
0
100
200
300


DEGREES CENTIGRADE
GAS OFF 1 HR 00 MIN
0 100 200 300 400 500 600 700 800 900 1000 1100 1200
4
3
7
3
2
12
6
1
5
4
11
10
9
8
UNEXPOSED SURFACE
THERMOCOUPLE LOCATIONS
X: SEE OTHER CHART
X X X X X X X X
X 2 X 3 X 1 4
5 10 6 7 11 8 9 12
I
II
III
START OF TEST
NAVILITE BULKHEADS UNEXPOSED SURFACE TEMPERATURES 8 IN. = 1 HR
CHART NO. 573
MINNEAPOLIS-HONEYWELL REG. CO., BROWN INSTRUMENTS DIVISION, PHILADELPHIA, PA.